Role of bacteria on the release of cesium from illite

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Role of bacteria on the desorption of cesium from illite

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Introduction

As a result of the nuclear accident in Fukushima, various radioactive elements such as **cesium** were dispersed in the atmosphere before being deposited **on the soil** within a distance of 80km around the nuclear power plant.

Cesium with half-life of 30 years and **properties similar to potassium accumulates in the clays**, especially illite, of the **upper soil horizons**.

Among soil remediation methods, phytoextraction is the most appropriate one as it can be achieved *in situ* without any change of the biophysicochemical properties of the soil.

Cesium uptake by plants depends on sorption/desorption reactions to/from the soil particles and on biogeochemical processes in the rhizosphere.

The coupling of bioaugmentation with phytoextraction is likely to increase the bioaccessibility of radionuclides and their accumulation in plants.

Objective: Return Cs in the solution of soil to be it available for plants.

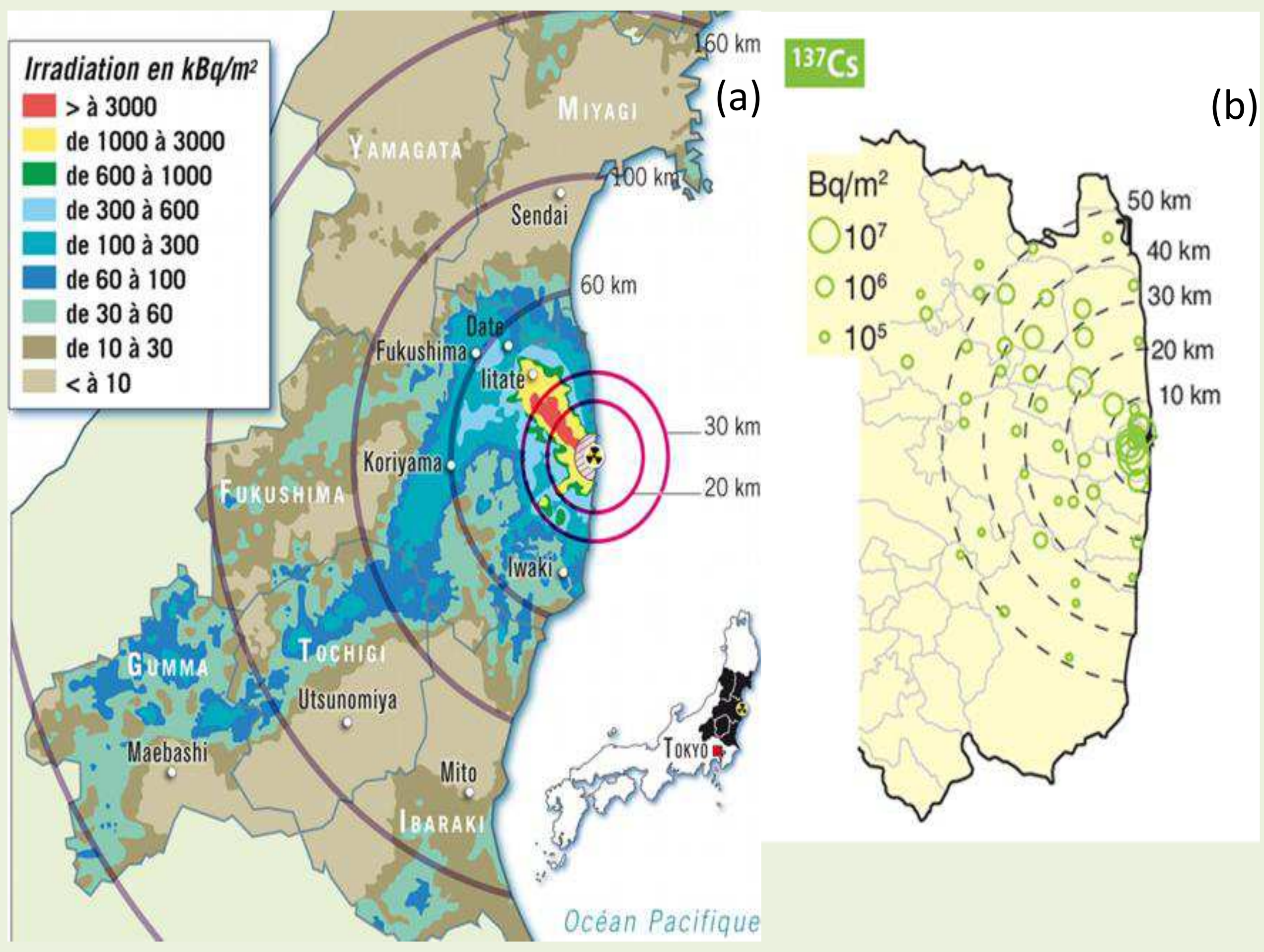

Fig 1 : The maps of the radioactivity distribution in the east of Fukushima prefecture; a: total irradiation; b: ^{137}Cs (Bq/m^2)

Material and methods

Illite powder was spiked 0,1 mM or 1 mM of CsCl : after analyse by ICP-MS-HR and tyndallization of illite (3 cycles at 75 °C separated by 24h of cooling), sterile solution of CsCl (100 mM) was used for treat illite with this concentrations.

Suspensions of Cs-treated illite in NaCl (0,1 mM) media and in Dworkin and Foster (DF) minimum media [1] were used for monitoring **Cs-desorption**. First, 0,04 mM **citrate** and 0,04 mM **oxalate** and then ***Pseudomonas fluorescens*** free and immobilized in dialysis membrane was tested as desorbing agents.

1 ml of suspension was taken after 1, 2, 4, 8, 24h and 2, 4, 6, 8, 10, 15 days and analysed by ICP-MS.

Results

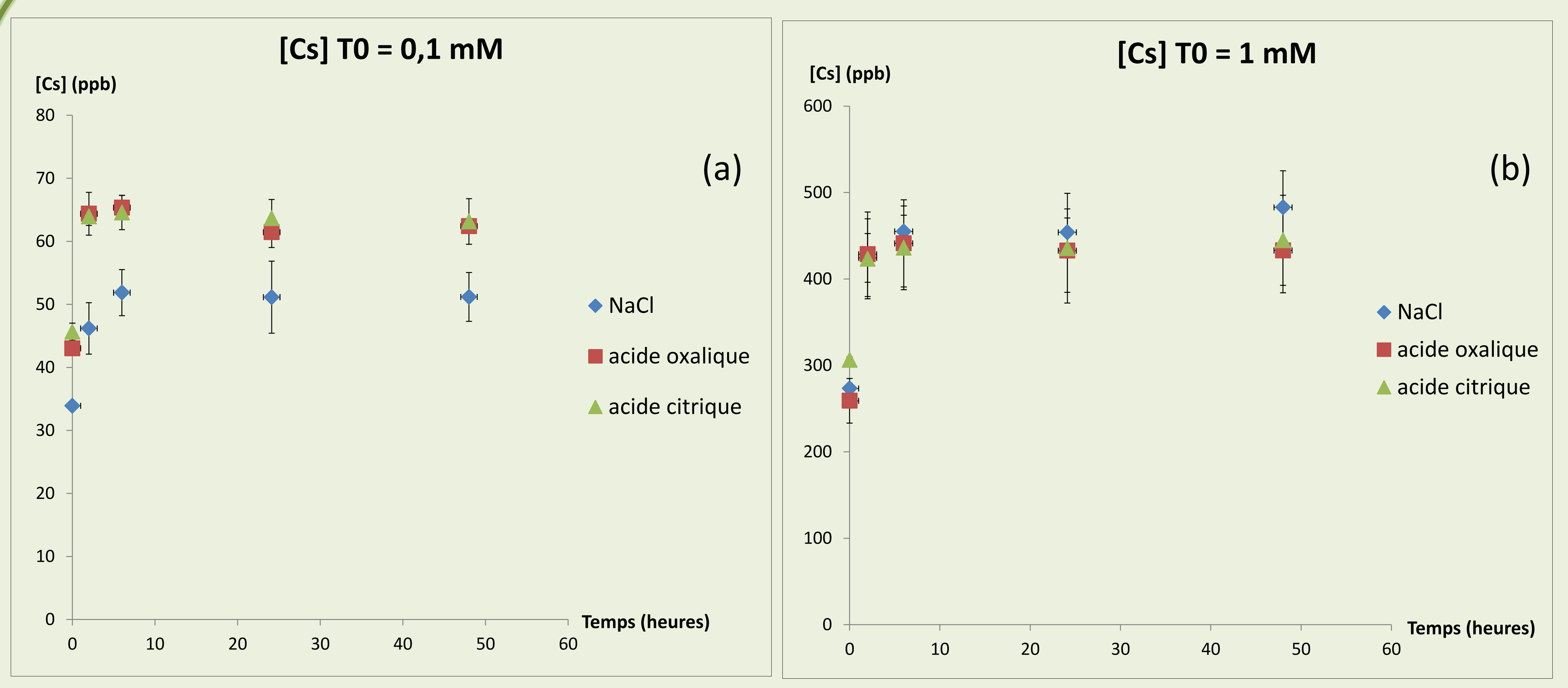

Fig 2 : Kinetic cesium desorption in NaCl media with oxalic acid and citric acid. Initial Cs concentration in illite was approximately 0,1 mM (a) and 1 mM (b).

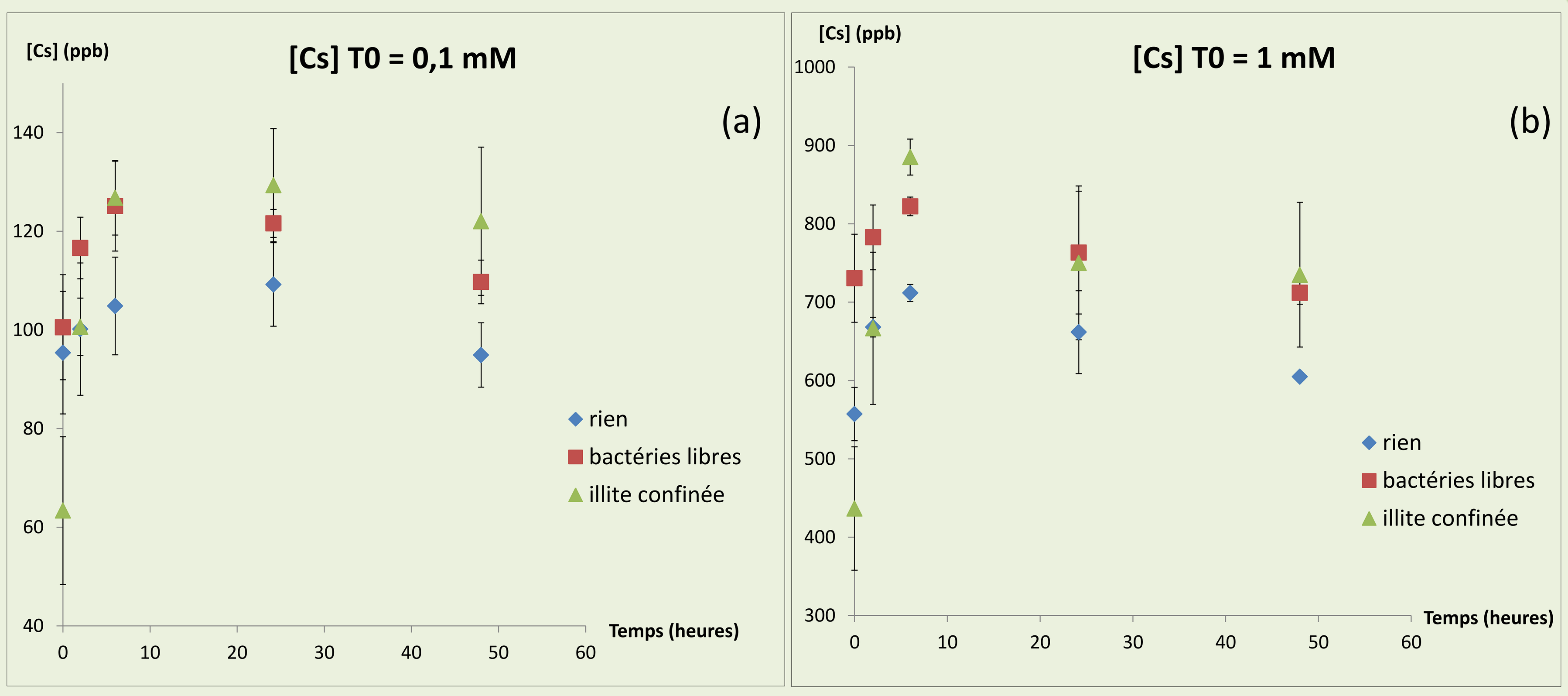

Fig 2 : Kinetic cesium desorption in NaCl media by free or immobilized bacteria. Initial Cs concentration in illite was approximately 0,1 mM (a) and 1 mM (b).

- Results do not provide for Cs desorption from illite by oxalic and citric acid in these concentrations.

Conclusion et perspectives

- Citric acid and oxalic acid do not provide to remove Cs from illite. This confirms the study of Wendling *et al.* (2005) in which it is shown that oxalic acid and citric acid does not allow desorbing Cs illite when in low Cs-concentrations [2].

Perspectives

- Analyse illite weathering by MET and MEB to determine interlayers size before and after bacteria addition and to observe the biofilm
- Use this experiment to desorbe strontium and americium from illite and then from contaminated soil.

References :
[1] Dworkin M. and Foster JW., 1958, Experiments with microorganisms which utilize ethane and hydrogen, Journal of bacteriology, 75:592-603.
[2] Wendling LA, Harsh JB, Ward T., Palmer CD., Hamilton MA., Boyle JS., and Flury M., 2005, Cesium Desorption from Illite as Affected by Exudates from Rhizosphere Bacteria, Environ. Sci. Technol., 39, 4505-4512.